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(54) Stretched wrapped package

(57) Stretchable plastics film (22) is applied to loads (200) using two rollers 34, 36 connected by change-speed gearing and driven by the film web so that the rollers are driven at different speeds to elongate the plastic film beyond its yield point and wrapping the thus-elongated film around the rotating load. "Roping" mechanisms for roping the whole sheet or the edges may be provided. The machine may be as in US Spec. 4110957 or 4050220.

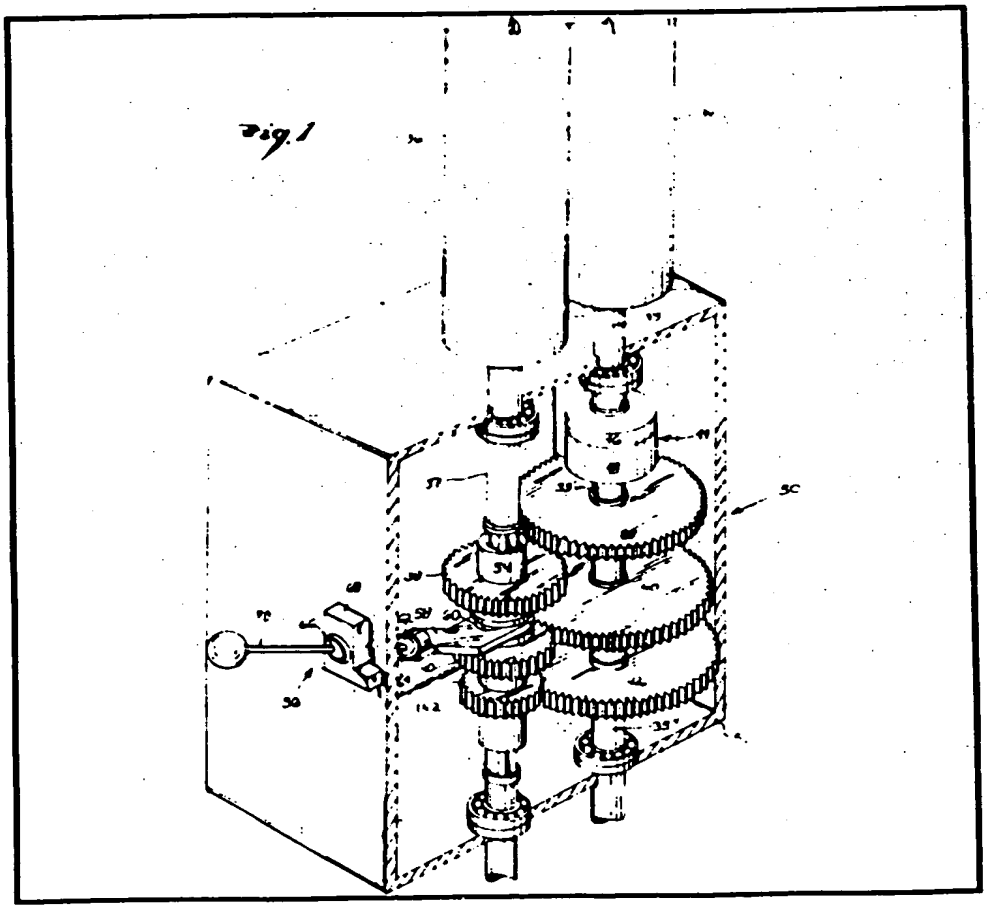

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Fig. 1

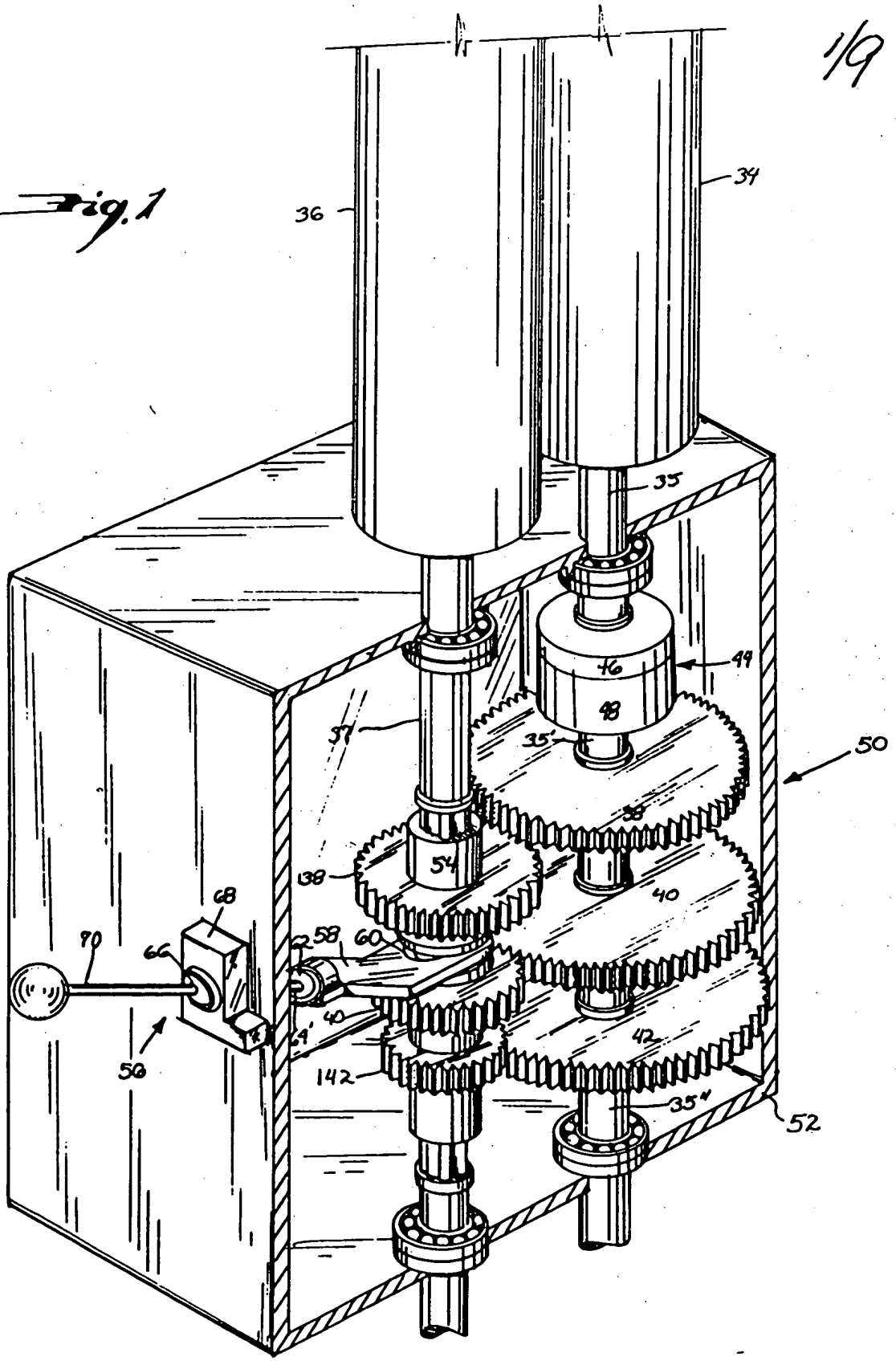


Fig.2

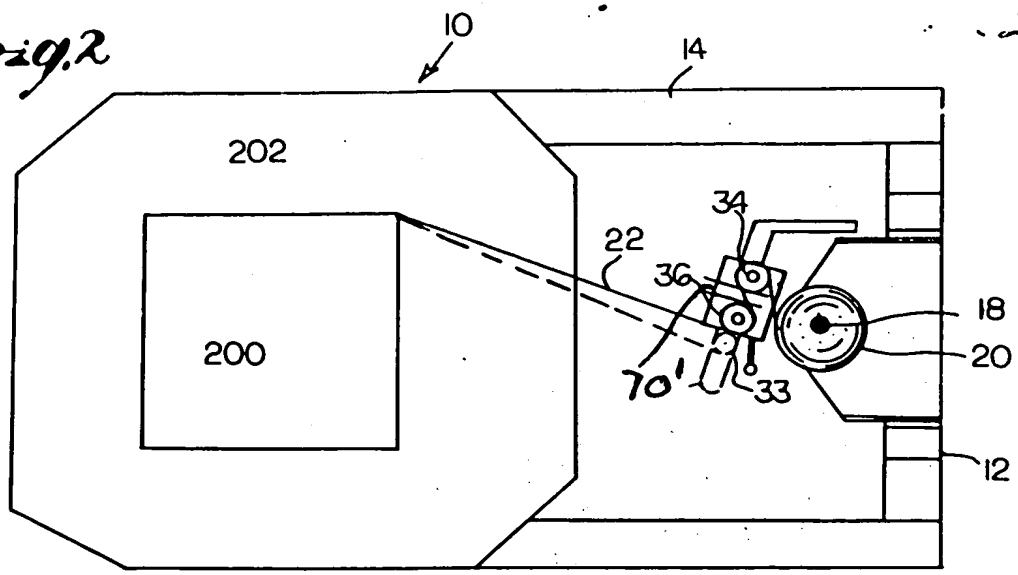


Fig 3

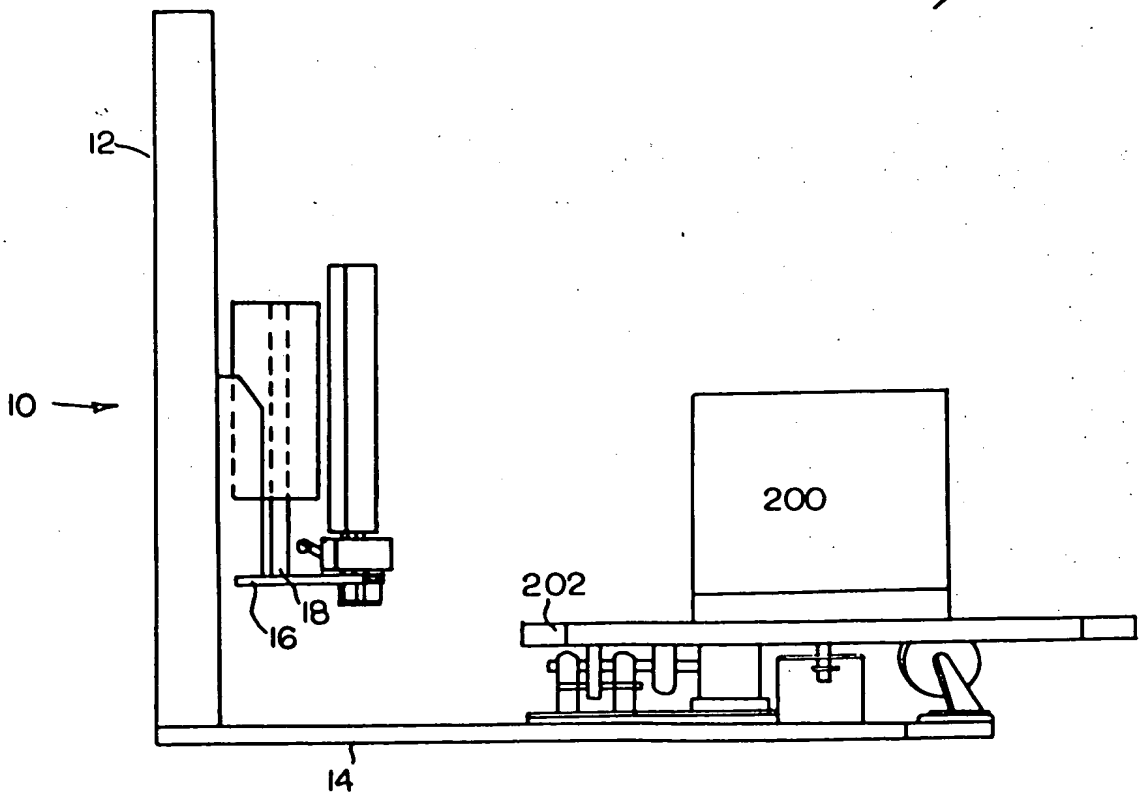


Fig 12

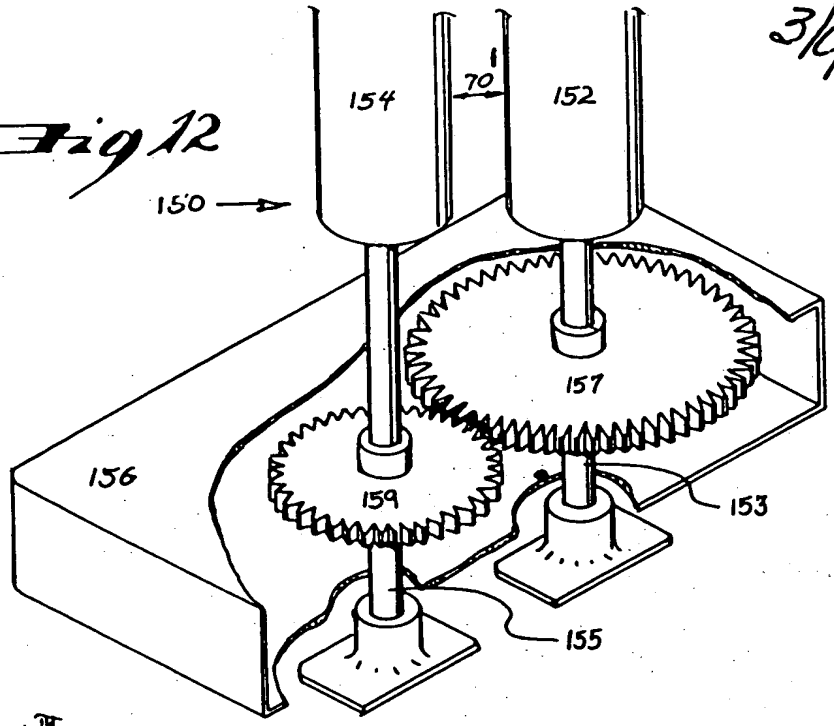
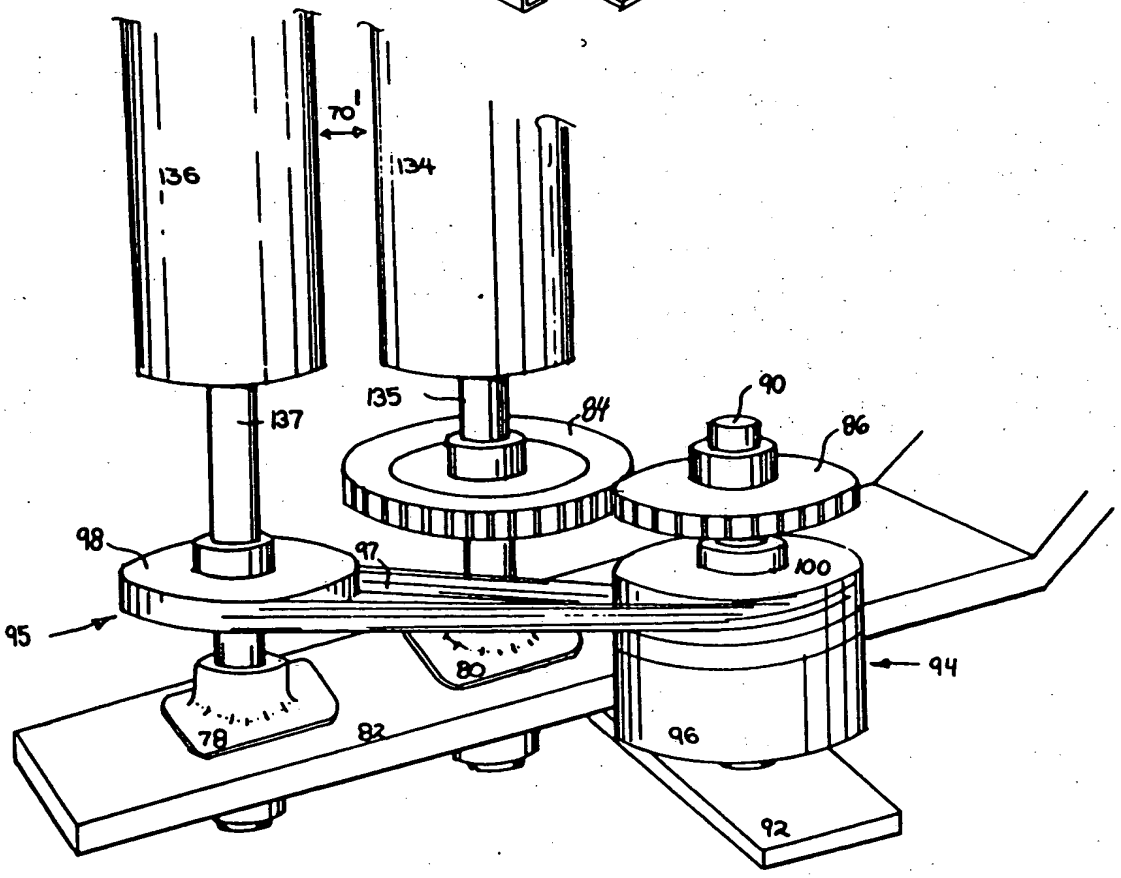

154
70'
152
150
157
156
159
153
155

Fig. 4


70'
136
134
135
84
90
86
137
98
97
100
95
80
94
78
82
96
92

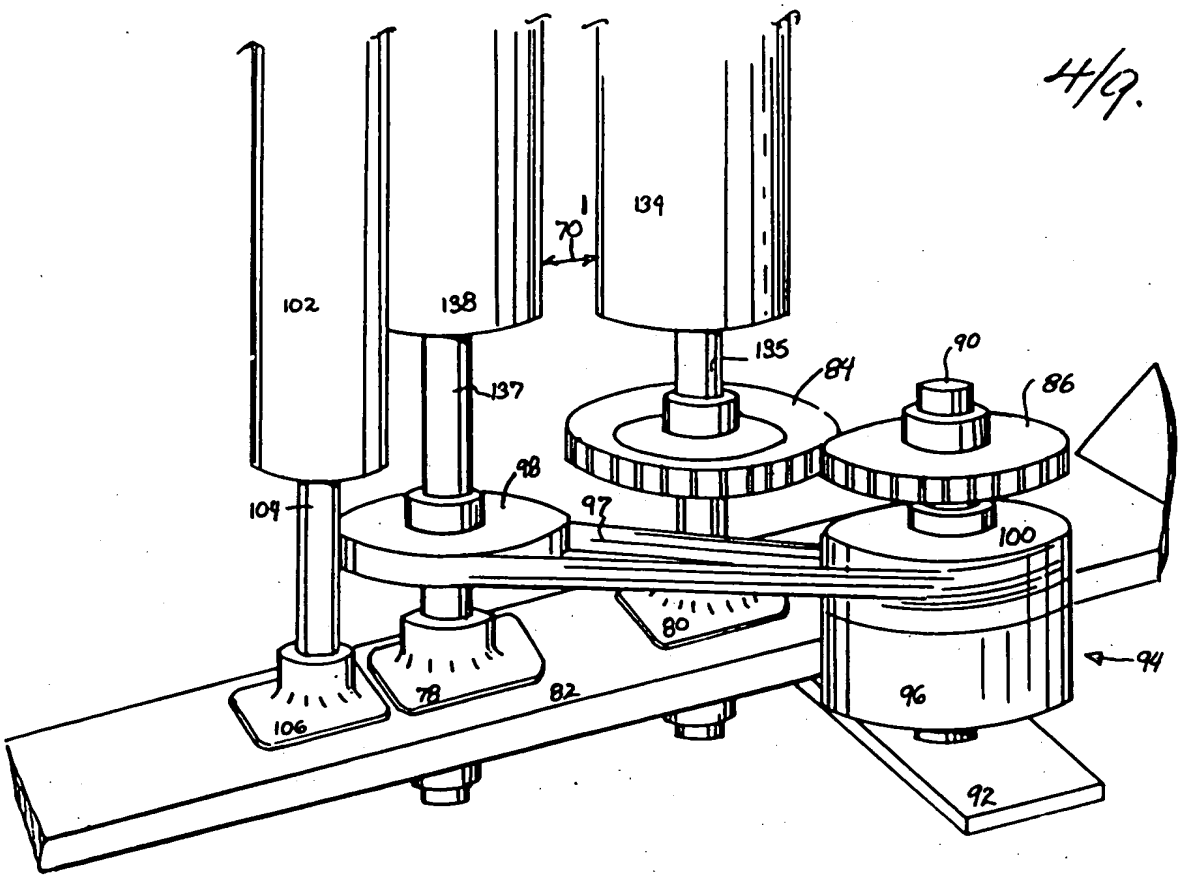

102
138
70
134
135
137
84
90
86
98
109
97
100
80
94
78
82
96
106
92

Fig 5

Fig 6

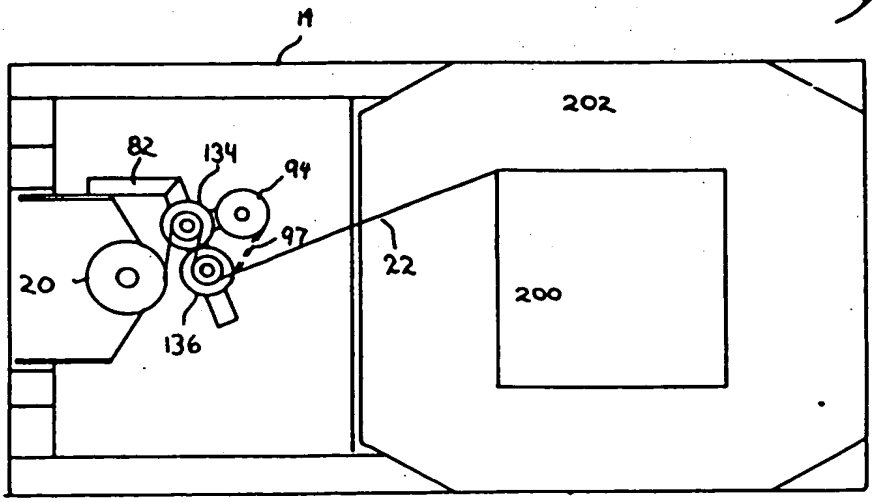

14
202
82
134
94
97
20
22
200
136

Fig. 7

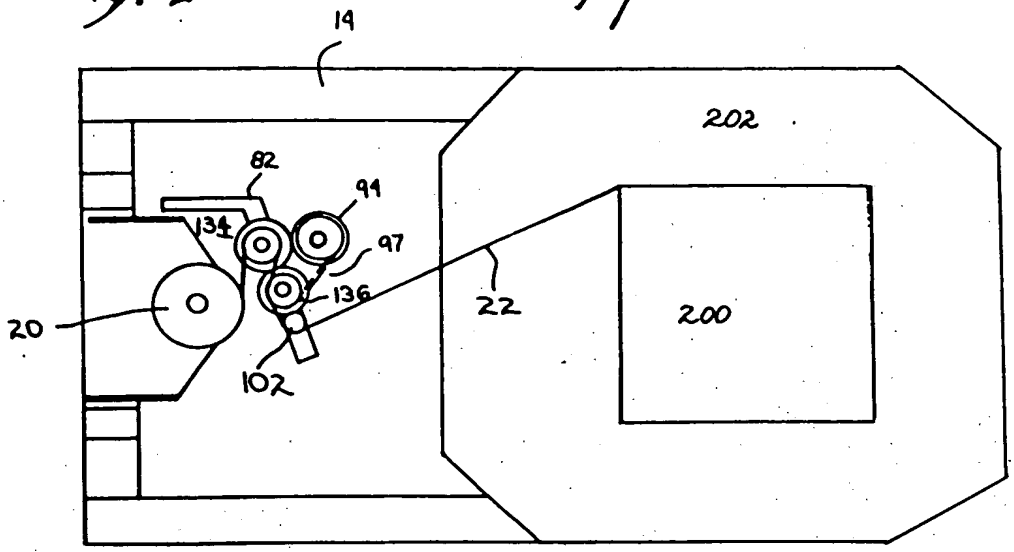


Fig. 8

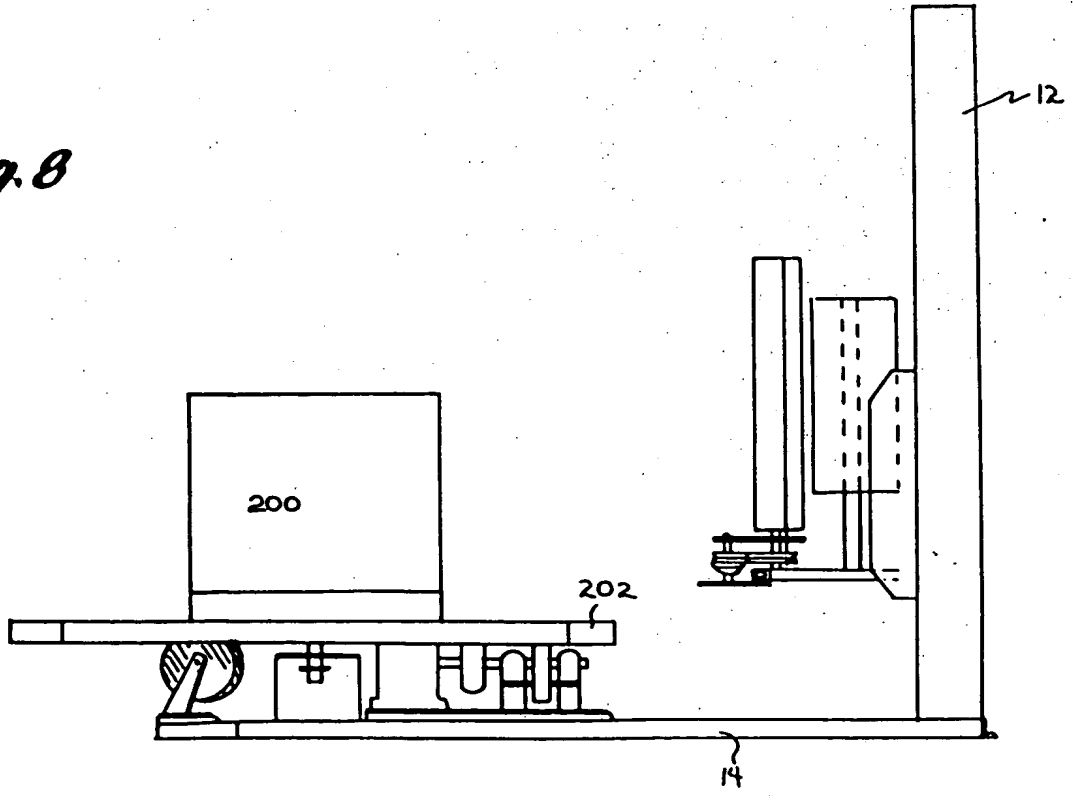


Fig 9

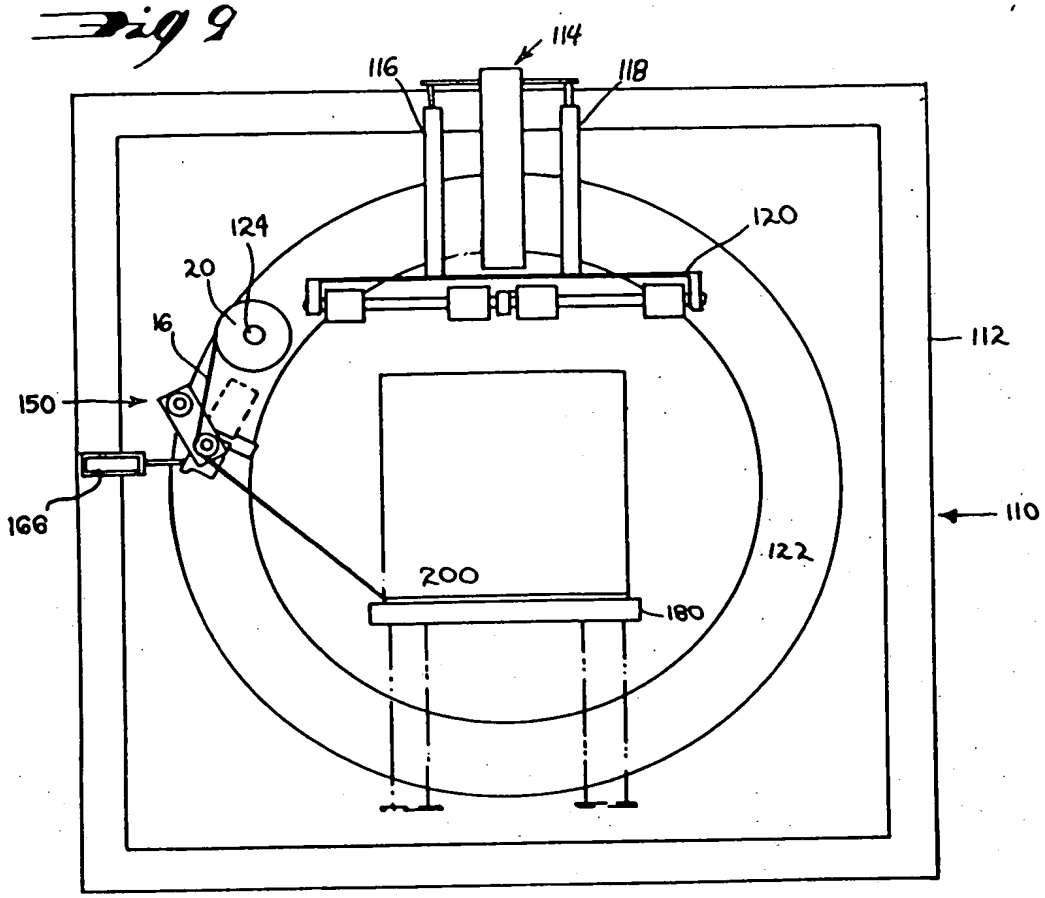


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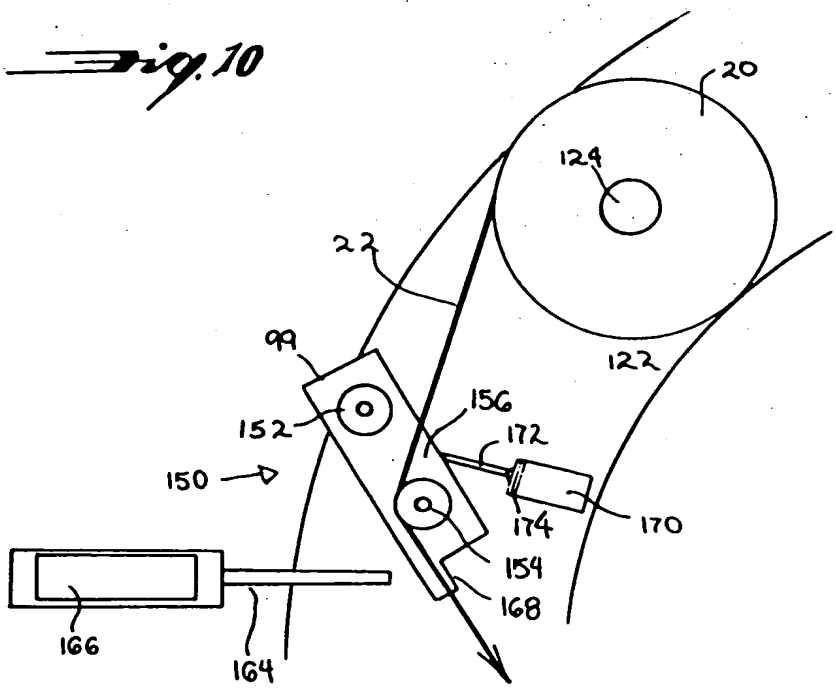
Fig. 10



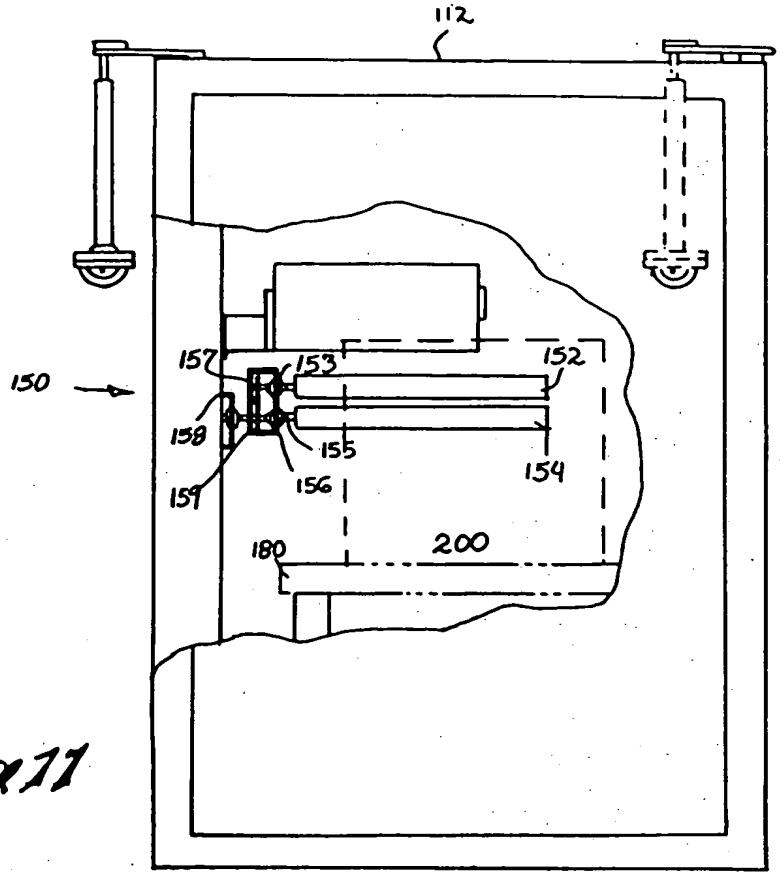
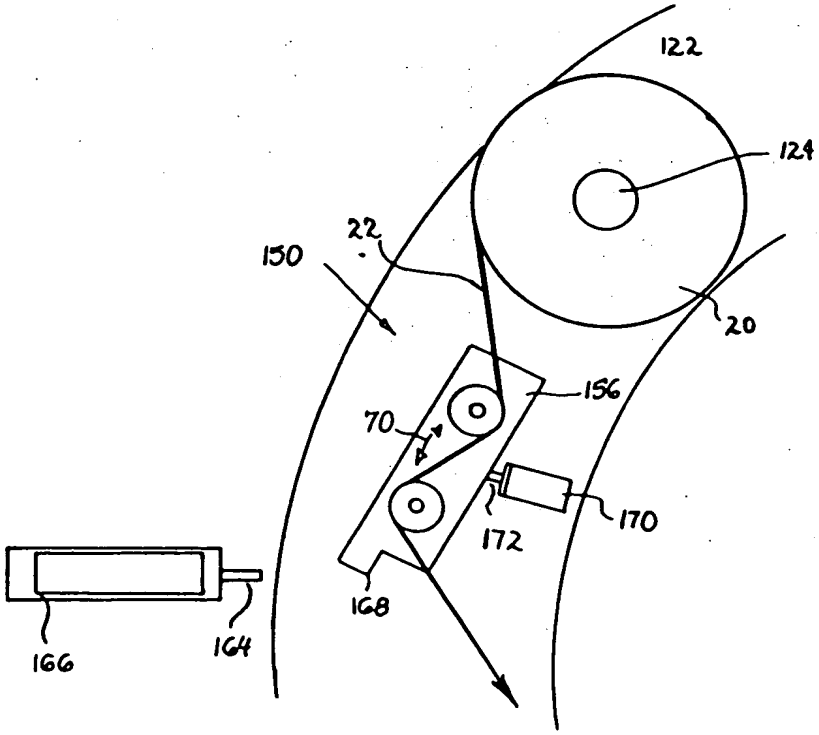

112
150
157
153
152
158
155
154
159
156
180
200

Fig 11

Fig 13


122
124
150
22
20
156
70
170
172
168
166
164

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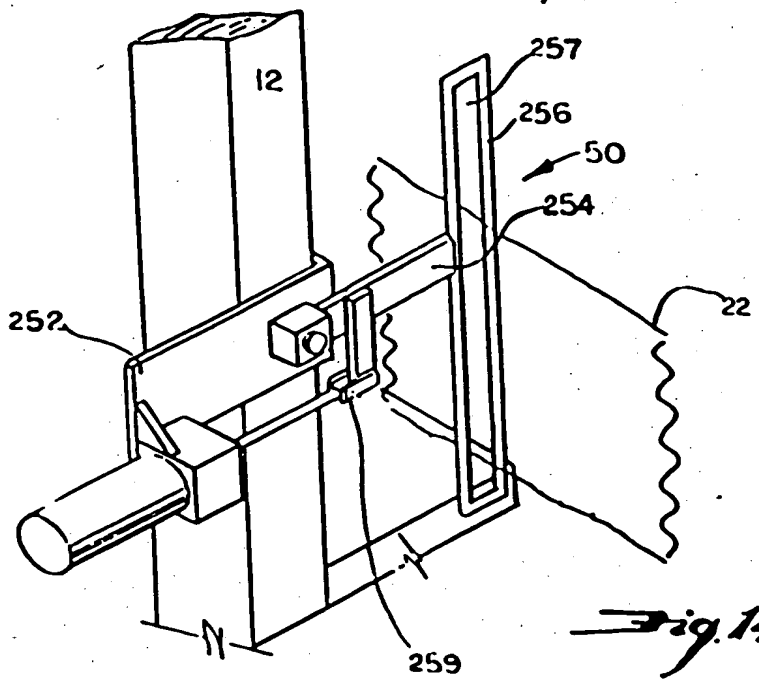

Fig. 14

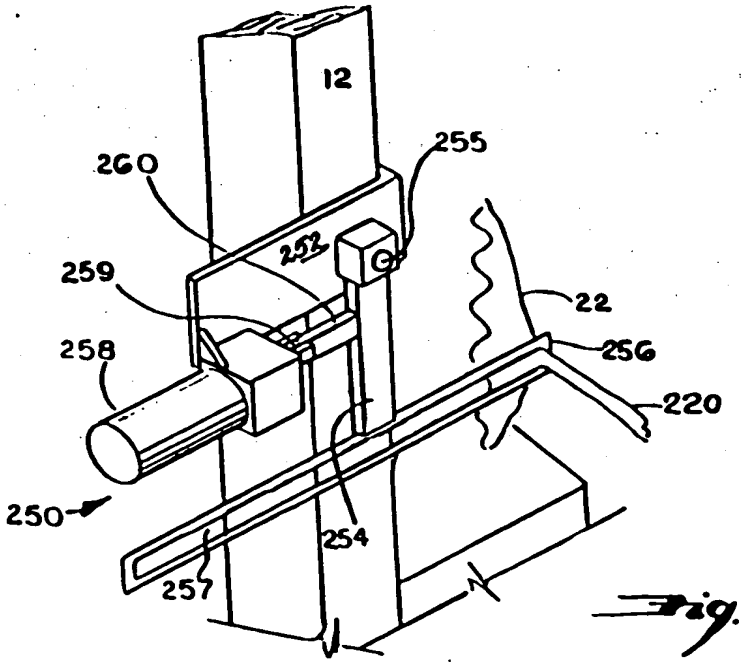

Fig. 15

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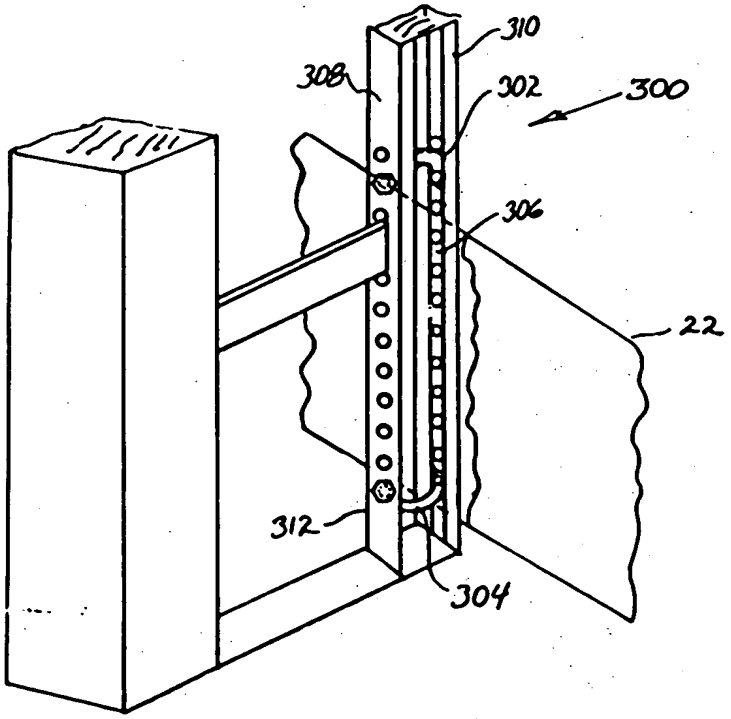

Fig 16

SPECIFICATION

Apparatus and method f r making a str tch d wrapped package

The present invention generally relates to packaging and more particularly to an apparatus and method for making unitary packages which hold a plurality of components, each package containing a load wrapped in a web of stretched film.

Case packing or boxing is a common way of shipping multiple units products. The multiple unit products are generally stacked in a corrugated box or are wrapped with kraft paper with the ends of the kraft paper being glued or taped. Another way of shipping such products is by putting a sleeve or covering of heat shrinkable film around the products and shrinkage the sleeve to form a unitized package. The use of heat shrinkable film is described in U.S. Patent Nos. 3,793,798; 3,626,645; 3,590,509 and 3,514,920. A discussion of this art is set forth in U.S. Patent No. 3,867,806.

The present invention does not require a structural seal and therefore can use any type of stretchable plastics material. The invention is designed to function with stretchable film webs such as nylon, polypropylene, PVC, polybutylene, polyethylene or any copolymer or blends of the aforementioned stretchable films.

The use of spiral wrapping machinery is well known in the art. One such apparatus is shown by U.S. Patent No. 3,863,425 in which film is guided from a roll and wrapped around a cylindrical load in a spiral configuration. A carriage drives the film roll adjacent the surface of the load to deposit a spiral wrap around the load and returns in the opposite direction to deposit another spiral overwrap around the load.

It has previously been disclosed in U.S. Patent No. 3,788,199 to spirally wind tapes in such a manner that they overlap each other to provide suitable space therebetween when breatheability is required. In this disclosure, a heavy duty bag is prepared by spirally winding stretched tapes of synthetic resin in opposite directions, so that they intersect each other to form a plurality of superimposed cylindrical bodies which are bonded together to form a cylindrical network. The spirally wound inner and outer tapes of the superimposed cylindrical body intersect each other at a suitable angle, depending upon the application intended, the preferred arrangement having substantially equal longitudinal transfer strength. In this preferred arrangement, the tapes intersect each other at an angle of about 90°. The angle defined by the tapes constituting the cylindrical network may be determined by varying the interrelationship between the travelling speed of the endless belts carrying the tape and the rotating speed of the bobbin holders, which rotate a plurality of tape bobbins to deposit the tape onto the moveable belt. The previously indicated patents rely on heat shrink material, adhesives, a heat seal or the tacky nature of the film to hold the outer layer of wrap in a fixed position.

In U.S. Patent No. 3,003,297, a rotatable cutting and holding mechanism is used to place a tape on a box and cut it off with the process being repeated for each box.

Additional references of interest which are pertinent to rotatable drives for wrapping packages are disclosed in U.S. Patent Nos. 3,820,451; 3,331,312; 3,324,789; 3,309,839; 3,207,060; 2,743,562; 2,630,751; 2,330,629; 2,054,603 and 2,124,770.

Other applications in packaging are shown in U.S. Patent Nos. 3,514,920 and 3,793,798 in which heat shrink film is wrapped around a pallet supporting a plurality of cartons. A full web apparatus which wraps stretched film around a rotating load is disclosed in U.S. Patent No. 3,867,806 assigned to Lantech, Inc. A similar full web apparatus using a tensioned cling film wrapped around a rotating load is shown by U.S. Patent No. 3,986,611 while another apparatus using a tacky PVC film is disclosed in U.S. Patent No. 3,795,086.

Stationary loads which are brought to a loading area and are wrapped by a rotating member which dispenses stretched film around a load are disclosed in U.S. Patent Nos. 4,079,565 and 4,109,445. U.S. Patent 4,079,565 discloses a full web vertical wrap of the load, while U.S. Patent No. 4,109,445 discloses the horizontal spiral wrap of a load.

The elasticity of the stretched plastics film holds the products of the load under more tension than either the shrink wrap or the kraft wrap, particularly with products which settle when packaged. The effectiveness of stretched plastics film in holding a load together is a function of the containment or stretch force being placed on the load and the ultimate strength of the total layered film wrap. These tw functions ar determined by the modulus or hardness of the film after stretch has occurred and the ultimat strength of the film after application. Containment force is currently achi v d by effecting longation until just below a critical point where braking of the film occurs. Virtually all str tch films on th market today including products of Mobil Company (Mobil-X, M bil-C Mobil-H), B rd n Resinite Divisi n PS-26, Consolidated Thermoplastics, Prest , PPD and others ar consistently str tched less than 30% in applications because of irr gularities in film braking systems. Thes syst ms depend upon friction induced drag either dir ctly on the film thr ugh a bar assembly such as that used by the Radient Engin ering C mpany or indirectly such as that sh wn in U.S. Pat nts Nos. 3,867,806 and

4,077,179.

All of these prior art apparatuses suffer from a severe limitation which relates to cost per unit load for film unitization. Friction brake devices do not maintain a consistent force. These brake devices are subject to variation due to their physical construction and their sensitivity to speed change caused by passage of corners of the load, and the resultant sudden speed up and slow down of film unwind. A typical 40" × 48" pallet load will incur a surface speed change of more than 40% with each quarter turn. Higher turntable speeds of 12 to 18 rpm produce additional resonating forces which change with a roll consumption and its resultant weight change. Additional limitations on maximum elongation are caused by film roll imperfections and gauge variations which accentuate the force variations described above to produce film ruptures. Even though all of the films previously described carry manufacturer's specified elongation rates above 300%, these rates cannot be approached because of limitations imposed by friction-type brake devices.

One problem with shrink and non-cling stretch film packaging in addition to the fact that they do not allow a load to breathe is that the primary strength and reliability of the package is determined by the consistent quality of the seal. These seals depend on a careful maintenance of the sealing jaw and are never as strong as the film itself. The time that it takes to make the seals is a limiting factor on the possible speeds of most shrink systems with the additional problem that some stretchable materials, as for example, stretch netting, or narrow width film cannot be effectively heat sealed.

In view of the previously stated characteristics of film, the previously noted stretch machines including machines manufactured by Lantech Inc.; Kaufman; Infra-Pak; PS & D: Allied Automatic; I. P. M.; and Mima have limited capabilities.

When high elongation rates of film are attempted, the forces frequently either disrupt the stacking pattern of the units or pull the load off of the turntable.

In addition non-vertical sides and corners on an irregular load place extreme forces on a small area of film during stretching, thereby causing a partial rupture at a point well below the force achieveable on a flat side. This partial rupture causes a transfer of force to the remaining portion of the web. This force is frequently sufficient to produce a "zippering" of the entire film web.

The present invention provides a process and apparatus for applying stretchable plastics film to pallet loads for containment of the loads using a pre-stretching mechanism in the form of two connected sets of rollers driven by the film web at different speeds to elongate the plastic film between the connected rollers as the film is wrapped around a rotating pallet. A web narrowing device may be placed upstream or downstream from the mechanism to reduce the hazard of edge tears under high elongation forces.

Thus, the present invention provides an apparatus and process which pre-stretches film before wrapping the film around a load so that the film may be elongated beyond its yield point before it is wrapped around the load holding the load under compressive forces.

Most plastics films when stretched above their yield point gain significantly in modulus and ultimate strength. The typical polyethylene will multiply three times the ultimate strength in pounds per square inch of cross sectional area after being elongated approximately 300 percent. This significant increase in strength begins approximately when the yield point is exceeded in the elongation phase. The yield point is achieved between 15 and 40 percent stretch for virtually all stretch films being used today. Limitations of friction-based constant force devices prevent current stretch wrap applications from achieving the higher levels of containment force and ultimate strength available in the foremost plastics films. Achieving the higher elongation levels with the invention allows fewer revolutions of film for equivalent holding power. These higher levels of stretch not only allow fewer revolutions of film but also less film by weight for each revolution.

Thus, the present invention allows at least double the practical level of elongation currently experienced with prior art "'brake" system. This gives higher containment forces and/or lower film costs to the end user.

Furthermore, the invention allows for more precise control of elongation allowing the user to get maximum cost efficiency from the new high yield films, along with higher film strength or modulus achieved at higher levels of elongation.

The higher levels of elongation which are achieved on the film can be achieved without disruptive or crushing forces on the load because of the mechanical advantage experienced between the pulling force to the pallet and the force between the rollers.

The novel construction in the invention provides for isolation of the film roll from stretch forces which eliminates premature film failure from roll end damage or roll down edges under force. The use of this simplified construction eliminates the use of friction brakes and freedom from the problems of those brakes such as speed variation, break away from stop position, temperature variation, wear and operator control meddling.

The use of the film web as the drive as opposed to motor driven devices also eliminates the need for compensation devices for corner passages, length/width variation or in turntable

speed, as well as liminating tension compensation devices.

It can thus b seen that the present invention provides a unique apparatus and process ... ... two rollers interconnected for speed differential are driven by film fr m the rotating load resulting in a pulling acti n on the film causing it to b stretched bef re it is applied to the load. A m chanical advantag is obtained all wing str tch during the pulling acti n and a slight strain recov ry after the pulling action is effected when the film is stretched above the yield point; and minimal frictional force is placed on the film after it leaves the rollers and is wrapped around the load. The present invention essentially eliminates the neck down of the film web normally experienced at high elongation rates. By limiting the stretching action to a minimum distance between the rollers and avoiding secondary stretch between the second roller and the load, web neck down is significantly reduced. The driving force is obtained by placing the rollers closely together and rotating in the opposite direction.

Th present invention will now be further described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of the roller assembly of the inventive apparatus with a portion of the apparatus broken away;

Figure 2 is a top plan view of the preferred embodiment of Fig. 1 incorporating the assembly of Fig. 1;

Figure 3 is a side elevational view of the embodiment shown in Fig. 2;

Figure 4 is a perspective view of another embodiment of the inventive apparatus with a portion of the apparatus broken away;

Figure 5 is a perspective view of the embodiment shown in Fig. 4 including an idle roller attachment;

Figure 6 is a top plan view of the embodiment of the invention incorporating the assembly of Fig. 4;

Figure 7 is a top plan view of the inventive embodiment including the assembly shown in Fig. 5;

Figure 8 is a side elevational view of the inventive embodiment shown in Fig. 6;

Figure 9 is a front elevational view of another embodiment of the inventive apparatus;

Figure 10 is an enlarged partial front elevational view of a pre-stretching assembly in an open positi n as shown in Fig. 9;

Figure 11 is a side elevational view of the embodiment shown in Fig. 9;

Figure 12 is an enlarged partial perspective view of a gear housing of rollers shown in Fig. 11;

Figure 13 is an enlarged front elevational view of the pre-stretching assembly in a closed stretching mode of operation;

Figure 14 is a partial perspective view of a web width changing mechanism of the apparatus when the web is in a full width open position;

Figure 15 is a partial perspective view of the web width changing mechanism when the mechanism is rotated to collapse the web into a rope; and

Figure 16 is a partial perspective view of a roping mechanism with moveable fixed fingers.

Of the wrapping apparatus 10 shown in Figs. 1 to 15, the preferred mode of the invention is that shown in Figs. 1 to 3. Alternate selected embodiments of the invention are shown in Figs. 4 to 8 and Figs. 9 to 13. The web narrowing aspect of the invention is shown in Figs. 14 and 15. The operation and description of the apparatus and its respective component parts are discussed in the following description.

The film web driven stretch wrapping apparatus 10 comprises an upright frame 12 sitting on a base 14. In the preferred embodiment, a carriage 16 is moveably mounted on the frame 12 as is known in the art, and is driven by rack and pinion, chain or other suitable drive means, which are also known in the art. Such stretch wrapping machines are well known in the art and are typified by machine Model Nos. SVS-80, SVSM-80, STVS-80, STVSM-80, and SAHS-80 manufactured by Lantech Inc. The apparatus 10 may also be a full web apparatus with the carriage removed, as is also well known in the art. Such machines are typified by machine Model Nos. S-65, SV-65 and SAH-70, manufactured by Lantech Inc. A typical state-f-the-art full web machine is also disclosed in U.S. Patent No. 3,867,806. A film unwind stand 18 which is also well known in the art is mounted on the carriage 16 or base 14 in the case of a full web machine. The stand is constructed with sufficient drag to allow smooth film, without backlash, to unwind from film roll 20 to a first roller 34 which is connected to a second roller 36. The r llers are closely spaced together at a distanc 70', geared f r r verse r tati n, and are rubber faced for maximum film contact. As is s n in Fig. 1, th rollers are connected by a g ar assembly 50, but it should be noted that they could also be connected by chains, belts r other mechanisms such as the ne shown in Fig. 4. Since most films reach their yield point before 30 percent elongation, the gear speed relationship should b variable from 30 percent to 300 percent to all w use on all stretch films which ar curr ntly available in the market. In this r gard, curr nt and modified low density poly thyl ne should be prestretch d t approximately

30 percent for optimum results. EVA copolymer films of high EVA content such as the film manufactured by Consolidated Thermoplastics "RS-50", Bemis "Super-T ugh" and PF . "Stay-Tight" are effectively pre-stretched to 50-80 percent. PVC films such as Borden Resinite PS-26 are best pre-stretched at levels of 40 percent allowing maximum dwell time befor restretch. Premium films such as Mobil-X, Presto Premium and St. Regis utiliz a new low pressure polymerization process resin manufactured by Union Carbide and by D w Chenical Company. This resin, called linear low density polyethylene, has significantly different stretch strength characteristics than previous stretch films. These characteristics allow the film to withstand the high stress of over 100 percent elongation during pre-stretch and then withstand the stress of driving the connected roller system without tearing during wrapping of the pallet. In the preferred embodiment of the invention as shown in Figs. 1 and 3, rollers 34 and 36 are r spectively secured to rotatable shafts 35 and 37 which are in turn mounted in respective j urnals, secured to a support member 42 or housing 52. The housing 52 is preferably secured to carriage stand 16. An idle roller 33 engaging roller 36 as shown in phantom in Fig. 2 can alternately be used with the invention to provide additional recovery time for the stretched film.

The gear changing assembly 50 comprises a housing 52 in which roller shafts 35 and 37 are r sp ctively rotatably mounted. Three gear members 38, 40 and 42 are mounted on shaft 35 and adapted to be rotated by the film web 22 engaging roller 34. A clutch assembly 44 is also m unted to shaft 35 connecting the shaft freewheel portion 35' to the shaft gear portion 35". A clutch plate 46 is secured to the end of shaft portion 35' opposite the face of clutch member 48 secured to the end of shaft portion 35". When the clutch is operative, the clutch plate 46 is held on the clutch face 48 so that the three gear members 38, 40 and 42 rotate simultaneously with roller 34. When clutch is not operative or energized, the roller 34 freewheels or turns with ut rotating the gears thus allowing a film web to be easily threaded through the roller assembly and attached to the load. The gear members 38, 40 and 42 are adapted to selectively engage and mesh with opposing gear members 138, 140 and 142 which are secured to sleeve 54, moveably mounted on shaft 37. The sleeve 54 is preferably splined or keyed so that it can be axially moved along the splined or keyed shaft 37 but driven by the shaft when the shaft turns. A shift mechanism 56 is used to selectively position the sleeve 54 along the shaft 37 so that a desired gear on sleeve 54 may be brought into meshing relationship with a corresponding gear on shaft 35 allowing the predetermined gear ratio to be obtained. The ratio of downstream r ller gear to upstream roller gear may be 4.363:1, for instance 3:26 5:2. e.g. 2:1. In this regard, it should be noted that gears 38, 40 and 42 are preferably constructed of plastics, while gears 138, 140 and 142 are constructed of steel or some different material to obtain a low coefficient of friction so that the apparatus will work with a minimum of friction. Alternately, gears 138, 140 and 142 and/or their associated sleeve 54 could be constructed of plastics and gears 38, 40 and 42 could be constructed of steel. The shift mechanism 56 comprises a member 58 with a yoke 60 on one end engaging sleeve 54 and adapted to move sleeve 54 along shaft 37. The other end of member 58 forms a seat for bearing 62 of shift arm 64. The shift arm 64 can extend outside of housing 52 or it can have a pivot bearing 66 mounted in journal 68 of housing 52. Extender arm 70 extends outside of housing 52 allowing the operator to shift into the desired gear ratio. The shift mechanism is adapted to hold the gear in a locked position of selective engagement or a neutral non-engaging position.

In another embodiment of the invention, as shown in Figs. 4 to 8, rollers 134 and 136 are respectively mounted onto shafts 135 and 137 which are in turn mounted in respective journals 78 and 80 secured to a support member 82 which is in turn secured to the carriage stand 16. A pinion gear 84 is mounted to shaft 135 of roller 134 and engages the teeth of an opposing gear 86 mounted to shaft 90 which is rotatably mounted in a journal (not shown) secured to cross member 92. The cross member 92 is secured to the support bar 82. A clutch assembly 94 comprising a clutch 96 and a variable double sheave 95 which is well known in the art is adapted to transmit the drive of roller 134 to roller 136 through a variable belt drive 97 mounted on a V-pulley 98 secured to shaft 90 and a V-pulley 100 which freewheels on shaft 90. Upon engagement of the clutch 96, the freewheeling pulley 100 is rotated by the shaft 90 to drive roller 136 at a variable speed which is dependent upon the particular setting of the variable belt 97. This type of drive is well known in the art and alternate variable speed drives could be substituted for the particular drive shown without departing from the scope of the invention. In this embodiment also, an idle roller 102 may be used, the roller being mounted on a shaft 104 rotatably supported in a bearing 106 carried on member 82.

An alternate embodiment of th invention is shown in Figs. 9 t 13 and utilizes an apparatus which rotates the film around the load rather than rotation of th turntable carrying the load. Such apparatus is disclosed in U.S. Patent N s. 4,050,220 and 4,110,957, assigned t Lant ch Inc. These patents are incorp rated by reference into th specification of this application. In the embodiment most plainly shown in Figs. 9 to 13, a rotating ring apparatus 110 is mounted on a fram 112. A load stabilizer 114 is also mounted on the frame 112 and has pneumatically operated cylind rs 116 and 118 conn cted to a load engagement m chanism

120. The cylinders 116, 118 are adapted to selectively drive the load engagem nt me 120 downward to hold the load 200 in a stable position during wrapping. The r tatable ring member 122 is rotatably mounted to the frame 112. Means of rotating such ring member 122 are well known in tho art and are shown in U.S. Patent Nos. 4,110,957 and 4,050,220. Such machines are typified by machine Model No. SAVRB manufactured by Lantech Inc.

A film roll 20 is mounted on the ring member 122 by placing it on a mandrel 124 secured to the ring member. The film web 22 is passed through a prestretching assembly 150 and tucked or fastened underneath load 200. The pre-stretching mechanism 150 comprises connected roller members 152 and 154 which are rotatably mounted on respective shafts 153 and 155 which are in turn journalled onto a housing 156 which is rotatably mounted by means of a pivot assembly 158 to the ring member 122. The rollers 152 and 154 are connected together by gears 157 and 159 as shown in Fig. 12 which mesh together and are driven as the film web 22 engages the rubber roller surfaces of the rollers driving the rollers. The gears 157 and 159 are similar to the gear members shown in Fig. 1 and operate in a similar manner so that the film web will drive the downstream roller at a faster rate than the upstream roller causing the film to be stretched between space 70 of the two rollers. The pre-stretching mechanism 150 is rotatable so that the film may be threaded through the mechanism and wrapped around the load 200 in a substantially unelongated condition until such time as at least a first corner of the load is covered with unstretched film.

Before the start of the film wrap, a pneumatic cylinder 166 mounted to frame 112 is activated causing piston rod 164 to extend outward and engage the cam portion 168 of housing 156, pushing the cam portion inward toward the center of the ring so that roller member 152 does not engage the film web 22. Since the connected roller members do not both engage the film web, the film web can be easily threaded through the mechanism and tucked into the load. After the leading edge of the film web has been tucked, the wrap cycle is activated by the operator and the piston rod 164 is retracted into the pneumatic cylinder away from housing 156. A coil spring (not shown) engages the housing and the shaft on which it is r tatably mounted to constantly urge the housing away from the center of the ring so that both roller members 152 and 154 will engage the film web 22. A fluid damper 170 of a type well known in the art secured to the ring member 122 engages a side of the housing 156 to prevent the roller member 152 from immediately engaging the film web. The piston 174 of the damper (Fig. 10) is provided with a suitable orifice allowing the force of the coil spring to gradually push piston rod 172 and its associated piston 174 inward at a predetermined speed allowing an appropriate amount of unelongated film web to be rotated around the load 200. The load 200 is mounted on a conveyor assembly 180 which can be powered or operated by push through method which are well known in the art.

In operation of the preferred embodiment as shown by Figs. 1 to 3, the film web 22 is pulled from the film roll and threaded through the film roll unwind stand and around the two rollers 34 and 36 and then attached to the load 200 by attaching it to a clamp mounted to the turntable or tucking it in the load. A release system such as clutch assembly 44 shown in Fig. 1 or clutch assembly 94 as shown in Fig. 4 can be used to ease the tucking or start up for full web or high modulus film applications. The turntable 202 is activated causing the film web 22 to be pulled across the first roller 34 thereby precisely increasing the speed for the second roller 36 to a predetermined ratio controlled by the gear assembly. As indicated in Fig. 1, the connection means can be a gear transmission or as shown in Fig. 4, a variable belt means. The film is thereby precisely elongated by a percentage represented by the relative speed differential of the rollers. When the friction in the system is minimal, the film elongation is halted when the web reaches the second roller. Thus, the film is held at a constant tension level for a period beginning with contact of the film on the second roller and ending when the film leaves contact with the second roller and moves toward the unit load 200. During this period, this strain achieved during the film elongation beyond the yield point is allowed to take a partial set and realize effective modulus.

As the film leaves the second roller, it normally experiences a stress reduction because of the mechanical advantage over the first pulling action represented by the speed difference of the r llers less any friction in the film unwind and roller system. This stress reduction causes inelastic strain recovery because the film was originally elongated beyond the yield point. When the apparatus is relatively friction free, meaning that the friction force is less than 10 percent of the force required to elongate the film, substantially all of the elongation occurs between th two closely spaced rollers 34 and 36. When the friction force is increased in th system, additional pulling forces occur on the film after it leaves the second roller and moves t ward the load. When the friction force in th system is such that l ss than 50 percent of the film elongation occurs betwe n the rollers it has b en noted that web breakage occurs which prevents effective usage of the apparatus. It should be noted that high friction forc causes necking down f the film after it l aves th second r ller which is an und sirable film characteristic. The unit load is then either spiral or full web wrapp d in a c nventional manner.

Where desirable, the film can be roped either upstream or downstream of the roller system is shown in Figs. 14 and 15. The roping mechanism 250 comprises a support plate 252 secured to the frame 12, and a rotatable support bar 354 having one end rotatably mounted to the support plate, the other end being secured to the web reduction member 256. Web reduction member 256 comprises a rectangular shaped bar which defines a rectangular aperture 257. The length of the rectangular aperture is greater than the width of the web of material used for wrapping the load and the thickness of the rectangular aperture is greater than the thickness of the web. Preferably, it is also equal to the desired thickness of the web when the edges are roped so that when member 256 is rotated, web material 22 is roped into a width 220 substantially equal to the width of aperture 257 as is best shown in Fig. 14.

A pneumatically activated cylinder 258 is secured to the support plate 252 or the frame and has an end 259 of its piston rod rotatably connected to drive bar 260 which is in turn rotatably secured to the rotatable support bar 254. Cylinder 258 can be energized by known fluid circuitry to move the rotatable support bar so that it rotates around the pivot point carrying the web reduction member 256 upward or downward in an approximately 90° arc. This causes the web material to be formed into a rope configuration 220 when the rectangular member is parallel to the ground or alternately allows free flow of the open web through the web reduction member 256 when the web reduction member is positioned substantially perpendicular to ground. While most roping procedures utilize the roping mechanism upstream from the prestretching apparatus; another roping mechanism 300 (Fig. 16) with moveable fixed fingers 302, 304 moveably mounted in grooves 306, 308 formed in guides 310, 312 may be placed upstream from the roll where continuous edge roping is desirable.

Friction can also be added to the film unwind or roller system where higher levels of elongation or containment are desirable and film or load profile characteristics allow.

Recent testing using a 40" × 48" pallet achieved 160 percent effective elongation on a load after a 200 percent pre-stretch using Mobil-X. An elongation on the load of 70 percent was achieved with PPD "Stay-Tight" 3520 film after a pre-stretch of 80 percent. Stretch levels were measured by printing "X" marks on the film at 10 inch intervals. The interval was measured on the pallet and the percentage calculated. Pulling force was monitored on the secondary action between the second roll and the pallet using strain gauge and strip recorder. Forces for all films tested were observed to be significantly below the theoretical forces required for the pre-stretch level to be achieved thus illustrating the mechanical advantage achieved. While friction prevents exact mechanical advantage force ratios from being realized, force monitoring indicated no distortion for corner passing, pallet centering on turntable or turntable speed. It should be noted that equivalent friction brake tests using Lantech model SVS-80 were able to obtain only a 50-60 percent elongation on Mobil-X and a 30-35 percent elongation on PPD "Stay-Tight" 3520. Thus it can be seen that the process and apparatus for elongating plastics film to overwrap products for containment using two pulling actions having mechanical advantage over each other provides significant improvement over the prior art. The first pulling action is separated by a period of controlled constant strain allowing the film to take a partial set. The pulling action elongates the film between two rollers connected to rotate at different speeds which isolates the elongation action from the film roll and the pallet load. The film is then held at that level of elongation for a period to time with the surface friction of the second roller. The second pulling action with a preferred force below the previous pulling action results from interconnection of the film between the second roller and the rotating unit load in the spiral and full web embodiment. The mechanical advantage of the second pulling action over the first allows very high stretching levels to be achieved during the first pulling action. The level of longation is typically double the level achievable with a friction brake. The lower forces experienced during the second pulling action results in some strain recovery because the yield point was exceeded and thus the force reduced. It should be noted at this point that the yield point is substantially defined by the tensile yield of the stretch film being used. The tensile yield under ASTM Test method D-882 for Mobile-X film is 980 P.S.I.; Mobil-H film, 1000 P.S.I. and Mobil-C film, 1000 P.S.I. Thus the force required to reach the yield point for a given film web is found by the formula:

$$\frac{\text{Cross sectional area} \times \text{tensile yield}}{1} = \text{force at yield point}$$

The yield point of a 20" × .0009 inch web of Mobil-X film would therefore by 19.5 pounds.

The common tests used to determine tensile yield are the ASTM D-882 and ASTM D-638. These lower forces allow overwrapping of the product at very high levels of elongation without disruption or crushing forces which would be incurred at equivalent levels of elongation using conventional brake type film stretch systems, if such systems could achieve the levels of longation obtained by using the prevent invention.

Special applications requiring high levels of containment force can add friction t th film unwind or r ller apparatus up to a level sufficient to produce elongation and higher c ntainment during the s cond pulling action.

It should be noted that the steps f the wrapping process can b interchangeable with ut departing from the scope f the invention. Furth rm re, thes steps can b interchanged and ar equivalent. In the for going description, th inventi n has be n described with reference to a particular preferred embodiment, although it is to be understood that the specific details shown are merely illustrative and the invention may be carried out in other ways without departing from the scope of the following claims.

CLAIMS

1. A process of making a unitary package by wrapping a plurality of units with a stretched film material overwrap forming a substantially rectangular load comprising the steps of:

a. withdrawing a leading end of a roll of stretchable film material on a dispenser means and passing the withdrawn film through at least two connected roller assemblies arranged in an upstream/downstream relationship and adapted to transport the film web at different speeds with the film web being driven at a faster speed downstream than it is upstream;

b. holding said material adjacent said load;

c. moving the load and/or the dispenser and roller assemblies to transport said film material thr ugh said connected roller assemblies causing said film material to drive the connected roller assemblies and elongate the film web allowing stretched material to be wrapped around the load; and

d. covering the load with a plurality of previously elongated film wraps thus produced so that th units of the load are held under a compressive force.

2. The process of claim 1, in which the roll contains more material than is needed to wrap n load, further including an additional step of severing said material from said prestretching means and fastening the trailing edge of said stretched material to at least one previously dispensed layer of overwrap.

3. The process of claim 1 or 2, wherein the film is of a plastics material.

4. The process of claim 3, wherein said material is allowed to realize inelastic strain recovery bef re it is wrapped around the load.

5. The process of claim 3 or 4, wherein said plastics material is elongated beyond its yield point between said roller surfaces.

6. The process of any of claims 3 to 5, wherein said plastics material is elongated by said prestretching means in a range of sixty percent to two hundred percent.

7. The process of any of claims 3 to 6, wherein said plastics material is elongated by said prestretching means at least one hundred percent over the percentage of stretch obtained by a friction brake.

8. The process of claim 6 or 7, wherein said plastics material is low density polyethylene.

9. The process of claim 3 or 4, wherein said plastics material is a polyvinylchloride film.

10. The process of claim 3 or 4, wherein said plastics material comprises a polypropylene polybutylene copolymer elongated by said prestretching means in a range of thirty five percent t ighty percent over its original configuration.

11. A process for spirally wrapping a web of stretchable material around a load comprising a plurality of units to form a unitary packaged load comprising:

a. withdrawing the leading end of a roll of stretchable material on a dispenser to form the web and passing the web through elongation means comprising at least two adjustably connected rollers which are arranged in an upstream-downstream relationship and which extend acr ss the web width of the stretchable material;

b. then holding the leading edge of said web adjacent a load comprising a plurality of units;

c. pulling the web through the elongation means when the elongation means is in an unc nnected state and wrapping the load to form at least part of a single turn of a spiral wrap;

d. pulling the web through the elongation means when the elongation means is in a connected state to drive the elongation means to stretch the material by increasing the speed of the film web through the downstream one of the the rollers as compared with the speed of the film web past the upstream one of the rollers to wrap elongated material around the load;

e. moving said material roll along an axis of the load to form a plurality of stretched wraps of material n said load; and

f. reversing the direction of said movement of said material to provide a plurality f second overwrapping wraps over said first wraps of material on said load to form a spiral wrap.

12. The pr c ss f claim 11, wherein said stretchable mat rial is longated past its yield point.

13. The pr c ss f claim 11 or 12, wher in said stretchabl material is subject d t a second str tching betw en th d wnstream roll r and the load.

14. The pr cess f any f claims 11 to 13, wher in said material is a plastics film mat rial.

15. The process of claim 14, wherein said plastics film material is a low density linear polyethylene.

16. The process of claim 13, 14 or 15, wherein said second stretching action elongates the material less than one hundred percent of the initial elongation.

17. The process of any of claims 11 to 16, wherein said stretchable material is elongated at least one hundred percent past its yield point.

18. The process of any of claims 11 to 17, wherein edges of said stretchable material are roped into a reduced film web width upstream of the roller elongation means.

19. The process of any of claims 11 to 17, wherein said stretchable material is roped into a reduced film web width upstream of the roller elongation means.

20. The process of any of claims 11 to 19, wherein said elongated web is netting.

21. A process for wrapping a web of stretchable film material around a load comprising a plurality of units to form a unitary package load comprising:

a. placing a roll of stretchable plastics material on a ring mechanism;

b. withdrawing the leading end of said web of plastic material from said roll through elongation means comprising a roller assembly mounted on said ring mechanism; the rollers of said assembly being positioned to extend across the web width of the stretchable material and comprising two connected rollers arranged in an upstream/downstream relationship;

c. holding the leading edge of said web of stretchable plastics material adjacent a load;

d. rotating said ring around said load causing said plastics material to be pulled through said roller assembly to drive said roller assembly;

e. elongating said stretchable material by pulling said web of material past the connected rollers of said roller assembly so that the downstream roller controls the upstream roller at a speed less than the speed of the downstream roller to cause the film web to be elongated past the yield point of the plastics material; and

f. wrapping said substantially elongated web around said load.

22. The process of claim 21 including the step of moving said load through said ring mechanism to form a spiral wrap of elongated material on said load.

23. The process of claim 21 or 22, wherein said stretchable plastics material is elongated beyond its yield point between said connected rollers.

24. The process of claim 23, wherein said stretchable plastics material is elongated beyond its yield point at least one hundred percent.

25. The process of any of claims 21 to 24, including the step of moving said roller assembly so that the film web passing through it is substantially unrestricted and at least a portion of the wrap around said load is comprised of film web in substantially its original state.

26. The process of any of claims 21 to 25, including the step of fastening an overlying layer of elongated material to an underlying layer of material.

27. An apparatus for making a unitary package from a plurality of units forming a load stacked on a pallet using a single web of stretchable plastics material to form the overwrap comprising a frame, a carriage movably mounted on said frame, a dispenser means mounted to said carriage, said dispenser means being adapted to hold and dispense a roll of stretchable material, a rotatable turntable adapted to receive and support a load comprising a plurality of stacked units located adjacent to said frame, drive means connected to said turntable and said associated load placed on said turntable, elongation means connected to said carriage adapted to receive stretchable material pulled from said dispenser means and elongate the material beyond its yield point, said elongation means comprising at least two connected and closely spaced apart rollers arranged in an upstream/downstream relationship and driven by the film web pulled from the dispenser means by the rotating turntable so that the downstream roller transports the film web faster than the upstream roller to cause the material to elongate before it reaches the load, and means to drive said carriage reciprocally along said frame so a plurality of overlapping layers of elongated material are placed on said load to form a wrapped tensioned unitary package, said carriage being driven along the frame to provide an overlapping spiral wrap for the load.

28. An apparatus for making a unitary package from a plurality of units forming a load using a single web of stretchable plastics material to form the overwrap, comprising a frame, a film dispenser means mounted on said frame, said film dispenser means being adapted to hold a roll of stretchable plastics film material and dispense the material, a rotatable turntable adapted to receive and support a load comprising a plurality of stacked units located adjacent to said frame, drive means connected to said turntable and adapted to rotate said turntable and said associated load placed on said turntable, elongation means connected to said frame adapted to receive stretchable plastics film material from said film dispenser means and elongate said plastic film material, said elongation means comprising two rollers arranged in an upstream/downstream relationship, spaced apart and connected to transmission means, said elongation means being driven by the film web pulled from the dispensing means by the rotating turntable so that the downstream roller transports the film web faster than the upstream roller to

cause the plastics material to elongate between the rollers with said plastics material receiving at least fifty percent of its elongation between the rollers before it reaches the load, the rotation of the turntable causing a plurality of layers of pre-stretched film material to be placed around said load to form a wrapped tensioned unitary package.

29. An apparatus as claimed in claim 28, wherein said transmission means are interconnecting gears, each gear being secured to the shaft of a roller.

30. Apparatus as claimed in claim 29, wherein the rotation ratio of a downstream roller gear to an upstream roller gear ranges from 3:2 to 5:2.

31. Apparatus as claimed in any of claims 28 to 30, including clutch means connected to said transmission means, said clutch means providing adjustable engagement of the transmission means.

32. Apparatus as claimed in claim 29, 30 or 31, wherein the rotation ratio of a downstream roller gear to an upstream roller gear produces a force on said plastics material greater than the:

$$\frac{\text{cross-sectional area of the film} \times \text{tensile yield of film}}{1}$$

33. Apparatus as claimed in claim 29, wherein the rotation ratio of a downstream roller gear to an upstream roller gear is in excess of 2:1.

34. Apparatus as claimed in any of claims 29 to 33, wherein the interconnecting gears are constructed from a different material to reduce friction.

35. Apparatus as claimed in any of claims 28 to 34, wherein said stretchable plastics film material is stretched beyond its yield point.

36. Apparatus as claimed in claim 29, wherein a downstream roller gear and an upstream roller gear are adapted to be disconnected by clutch means mounted to one of said roller member shafts and are constructed of different materials to reduce friction.

37. An apparatus as claimed in claim 29, wherein said transmission means includes a clutch adapted to adjustably engage said gears.

38. An apparatus as claimed in claim 28, wherein said transmission means is a variable belt mechanism comprising a gear engaging a gear on one roller and a double split sheave assembly connected to a pulley member mounted to the other roller, said clutch being operative to adjustably engage said double split sheave assembly.

39. Apparatus as claimed in any of claims 28 to 38, including an idle roller means mounted downstream of said roller assembly.

40. An apparatus as claimed in claim 28, wherein said transmission means comprises a gear transmission assembly including a plurality of gears adapted to selectively interconnect to provide a selective gear ratio.

41. An apparatus as claimed in claim 40, wherein said gear transmission means comprises a plurality of gears secured to a shaft holding one roller member and a plurality of gears mounted on a sleeve slidably mounted on a shaft of the other roller member, said sleeve being rotatable on the shaft to provide selective engagement of the gears on both shafts to arrive at a preselected gear ratio ranging from 4:3 to 3:1.

42. An apparatus for making a unitary package from a plurality of units forming a load using a single web of stretchable plastics material to form the overwrap, comprising a frame, a ring member rotatably mounted on said frame, means to rotate said ring member on said frame, a film dispenser rotatably mounted on said ring member and adapted to hold and dispense a roll of stretchable material, elongation means mounted to said ring member adapted to stretch said stretchable plastics material beyond its yield point, said elongation means comprising at least two connected and closely spaced apart rollers arranged in an upstream/downstream relationship and driven by the film web pulled from the dispenser so that the downstream roller transports the film web faster than the upstream roller to cause the material to elongate between the rollers before it reaches the load, so that the load is wrapped with a plurality of wraps of elongated plastics material.

43. An apparatus as claimed in claim 40, including means to move said load through said ring mechanism while said ring mechanism is rotating.

44. A process for making a unitary package of a plurality of units, substantially as hereinbefore described with reference to Figs. 1 to 3 or to Figs. 4 to 8 or to Figs. 9 to 13 of the accompanying drawings.

45. A process for making a unitary package of a plurality of units, substantially as hereinbefore described with reference to Figs. 1 to 3 or to Figs. 4 to 8 or to Figs. 9 to 13 and Figs. 14 to 16 of the accompanying drawings.

46. Apparatus for making a unitary package of a plurality of units, substantially as hereinbefore described with reference to Figs. 1 to 3 or to Figs. 4 to 8 or to Figs. 9 to 13 of the accompanying drawings.

47. Apparatus for making a unitary package of a plurality of units, substantially as hereinbefore described with reference to Figs. 1 to 3 or to Figs. 4 to 8 or to Figs. 9 to 13 and Figs. 14 to 16 of the accompanying drawings.

CLAIMS (19 Mar 1981)

1. A process of making a unitary package by wrapping a plurality f units with a stretched film material overwrap forming a substantially rectangular load comprising the steps of:

a. withdrawing a leading end of a roll of stretchable film material on a dispenser means and passing the withdrawn film through at least two connected roller assemblies arranged in an upstream/downstream relationship and adapted to transport the film web at different speeds with the film web being driven at a faster speed downstream than it is upstream;

b. holding said material adjacent said load;

c. rotating the load relative to the dispenser to transport said film material through said connected roller assemblies causing said film material to drive the connected roller assemblies and elongate the film web allowing stretched material to be wrapped around the load; and

d. covering the load with a plurality of previously elongated film wraps thus produced so that the units of the load are held under a compressive force.

11. A process for spirally wrapping a web of stretchable material around a load comprising a plurality of units to form a unitary packaged load comprising:

a. withdrawing the leading end of a roll of stretchable material on a dispenser to form the web and passing the web through a stretching mechanism comprising at least two adjustably connected rollers which are arranged in an upstream/downstream relationship and which extend across the web width of the stretchable material;

b. then holding the leading edge of said web adjacent a load;

c. pulling the web through the stretching mechanism by causing relative rotation between the load and the dispenser when the stretching mechanism is in an unconnected state; and

d. pulling the web through the stretching mechanism when the stretching mechanism is in a connected state to drive the connected rollers of the stretching mechanism and stretch the material by increasing the speed of the film web through the downstream one of the rollers as compared with the speed of the film web past the upstream one of the rollers to wrap stretched material around the load.

21. A process for wrapping a web of stretchable film material around a load comprising a plurality of units to form a unitary package load comprising:

a. placing a roll of stretchable plastics material on a ring mechanism;

b. withdrawing the leading end of said web of plastics material from said roll through l ngation means comprising an assembly of rollers mounted on said ring mechanism; the rollers of said assembly being positioned to extend across the web width of the stretchable material and comprising two connected rollers arranged in an upstream/downstream relationship;

c. holding the leading edge of said web of stretchable plastics material adjacent a package;

d. rotating said ring around said package causing said plastics material to be pulled through said roller assembly to drive said roller assembly;

e. elongating said stretchable material by pulling said web of material past the connected rollers of said roller assembly so that the downstream roller controls the upstream roller at a speed less than the speed of the downstream roller to cause the film web to be elongated past the yield point of the plastics material; and

f. wrapping said substantially elongated web around said package with a force less than the maximum incurred between the rollers.

27. An apparatus for making a unitary package from a plurality of units forming a load using a single web of stretchable plastics material to form the overwrap, comprising a frame, a dispenser means, said dispenser means being adapted to hold and dispense a roll of stretchable material, means adapted for relative rotation between the load and the dispenser means, elongation means connected to said dispenser means and adapted to receive stretchable material pulled from said dispenser means, said elongation means comprising at least two c nnected and closely spaced apart rollers arranged in an upstream/downstream relationship and interconnected by speed control means and driven by the film web pulled from the dispenser means by relative rotation of the load, said rollers being acted upon by said speed control m ans so that th d wnstream roller transports the film web faster than the upstream roller t cause the material to stretch b fore it pass s the downstream r ll r with the mechanical advantage of pulling force over str tching force b tween r llers being sufficient to maintain pulling force l ss than str tching force.

28. An apparatus for making a unitary package form a plurality of units f rming a l ad using a single web f str tchabl plastics material to form th overwrap, comprising a frame, a film disp nser means m unted on said fram , said film dispens r means being adapt d t hold a roll f str tchable plastics film material and dispens th mat rial, m ans for relative r tation

of th load and the dispenser means, elongation means connected to said frame adapted to receive stretchable plastics film material from said film dispenser means and elongate said plastic film material, said elongation means comprising two rollers arranged in an upstream/d wnstream relationship, and connected to roller speed control means, said elongation means being driven by the film web pulled from the dispenser means by the relativ rotati n f the load so that the downstream roller transports the film web faster than the upstream roll r to cause the plastics material to elongate between the rollers with said plastics material receiving at least fifty percent of its elongation between the rollers before it reaches the load, the rotation of the turntable causing a plurality of layers of pre-stretched film material to be placed around said load to form a wrapped tensioned unitary package.

42. An apparatus for making a unitary package from a plurality of units forming a load using a single web of stretchable plastics material to form the overwrap, comprising a frame, a ring member rotatably mounted on said frame, means to rotate said ring member on said frame, a film dispenser rotatably mounted on said ring member and adapted to hold and dispense a roll of stretchable material, elongation means mounted on said ring member and adapted to stretch said stretchable plastics material beyond is yield point, said elongation means comprising at least two connected and closely spaced apart rollers arranged in an upstream/downstream relationship and driven by the film web pulled from the dispenser so that the downstream roller transports the film web faster than the upstream roller to cause the material to elongate between th rollers before it reaches the load, so that the load is wrapped with a plurality of wraps of elongated plastics material.

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